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Meguro et al.

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(54) **BELT DEVICE AND IMAGE FORMING APPARATUS**

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G03G 21/00 (2006.01)
G03G 15/01 (2006.01)

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CPC ***G03G 15/161*** (2013.01); ***G03G 21/007*** (2013.01); ***G03G 15/0189*** (2013.01); *G03G 15/1615* (2013.01); *G03G 2215/0132* (2013.01); *G03G 2215/1661* (2013.01)
USPC **399/101**; 399/121; 399/299

(58) **Field of Classification Search**
CPC G03G 15/161; G03G 15/1615; G03G 21/007; G03G 2215/1661
USPC 399/101, 121, 299
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A belt device includes: a belt that passes through a plurality of image forming units, each of the image forming units including a transfer member and an image carrier as a pair, the transfer member moves in a direction to contact with the belt and in a direction so as to be separated from the belt; a cleaning unit cleans an outer periphery of the belt after the belt passes through all the image forming units; and a pressing member is disposed between the cleaning unit and the image forming unit located on the most upstream side and that presses the outer periphery of the belt, wherein when the transfer member of at least one of the image forming units moves to be separated from the belt, the transfer member of the rest of the image forming units and the pressing member support the belt.

8 Claims, 8 Drawing Sheets

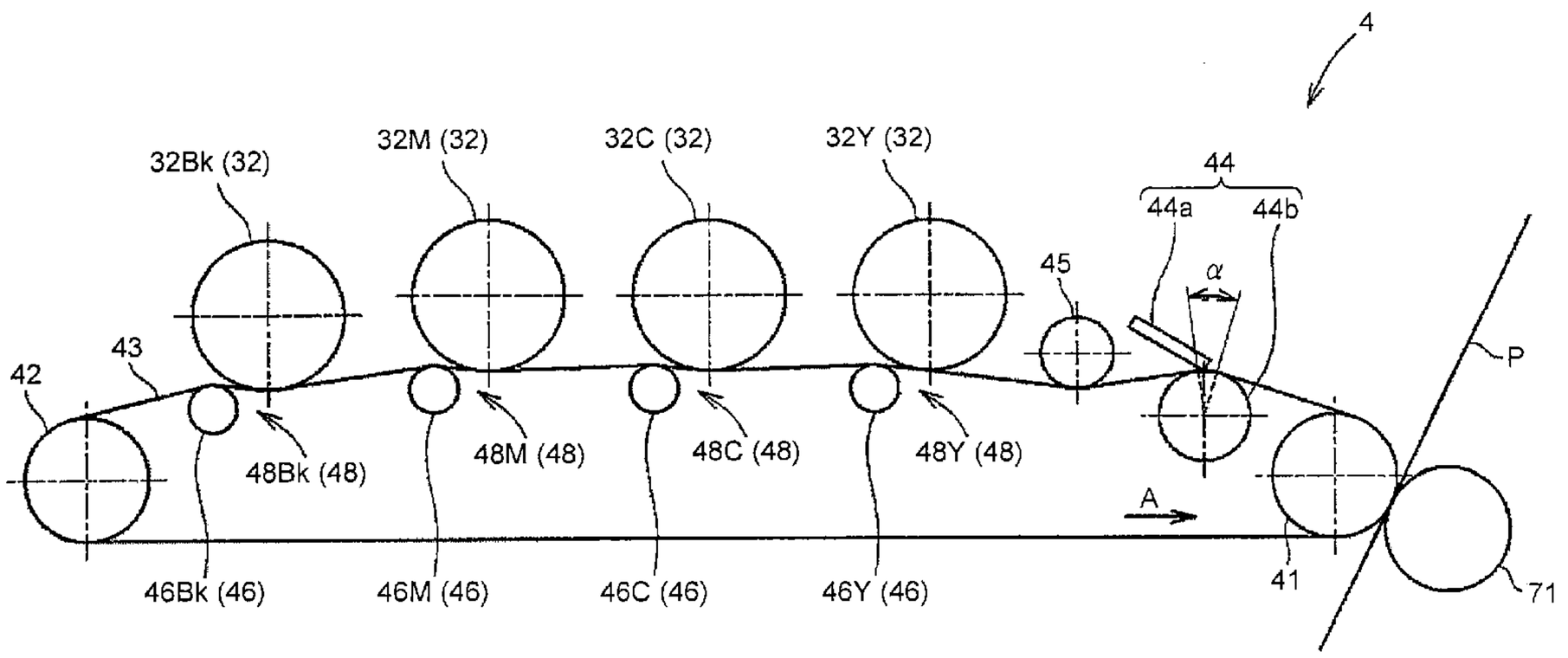

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FIG.1

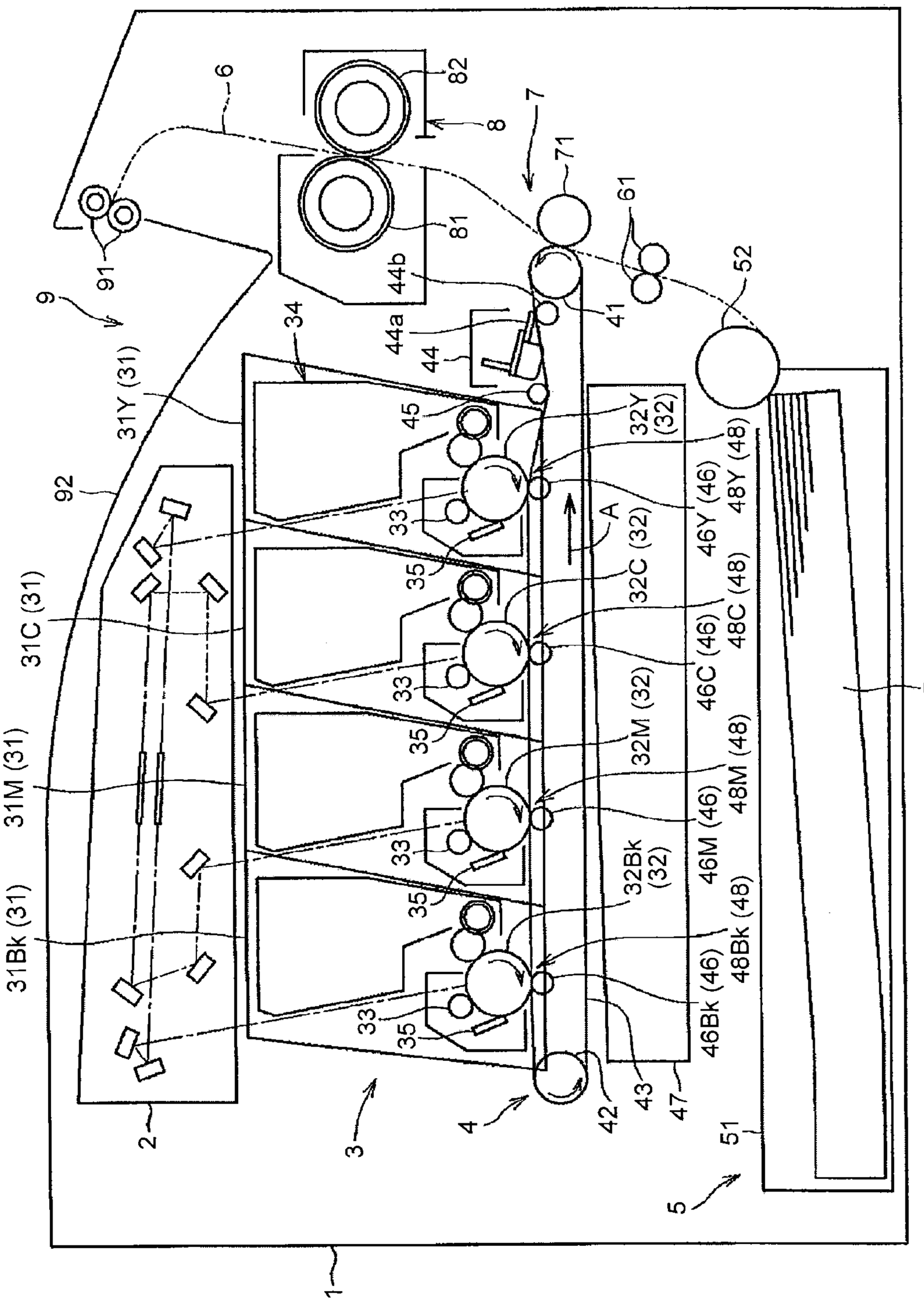

6
82
8
7
71
61
91
81
44b
52
9
34
41
44a
44
45
31Y (31)
92
32Y (32)
33
A
35
31C (31)
32C (32)
46Y (46)
48Y (48)
48C (48)
46C (46)
31M (31)
32M (32)
48M (48)
46M (46)
32Bk (32)
31Bk (31)
48Bk (48)
46Bk (46)
P
2
3
4
42
43
47
51
5
1

FIG.2

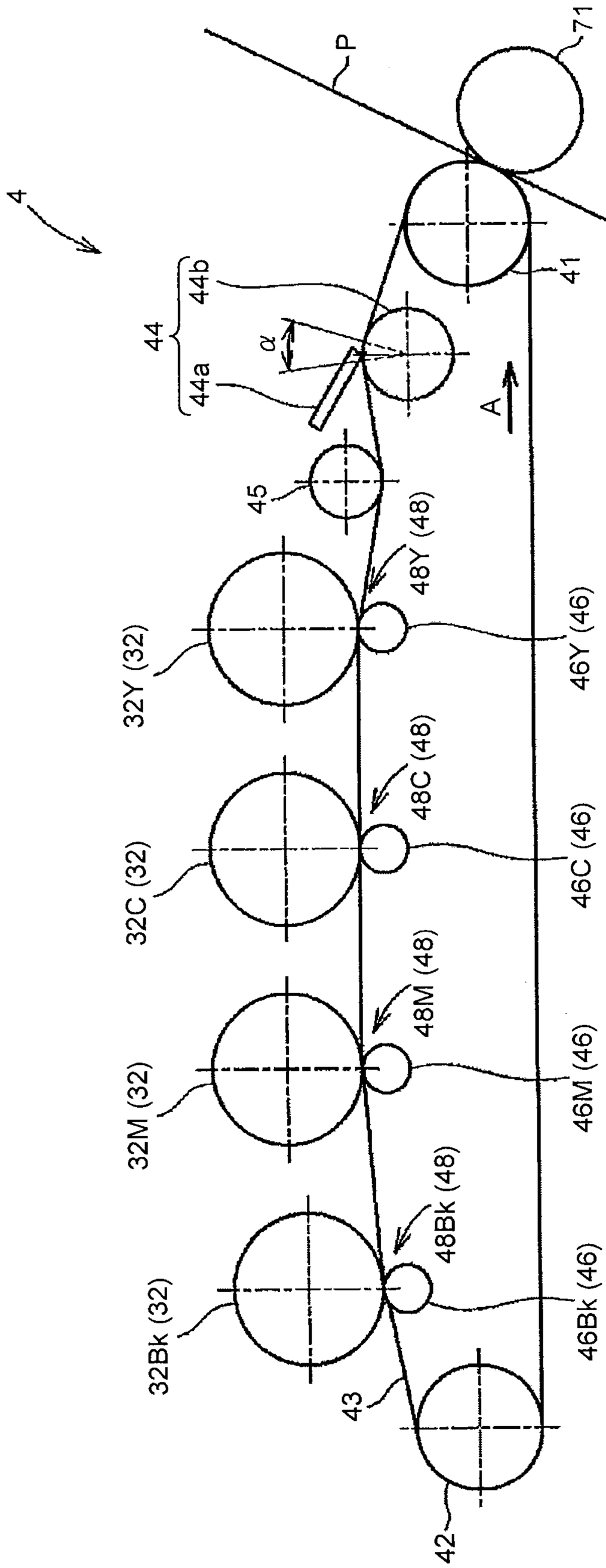

4
P
71
41
44
44b
44a
α
A
45
48Y (48)
32Y (32)
46Y (46)
48C (48)
32C (32)
46C (46)
48M (48)
32M (32)
46M (46)
48Bk (48)
32Bk (32)
46Bk (46)
43
42

FIG.3

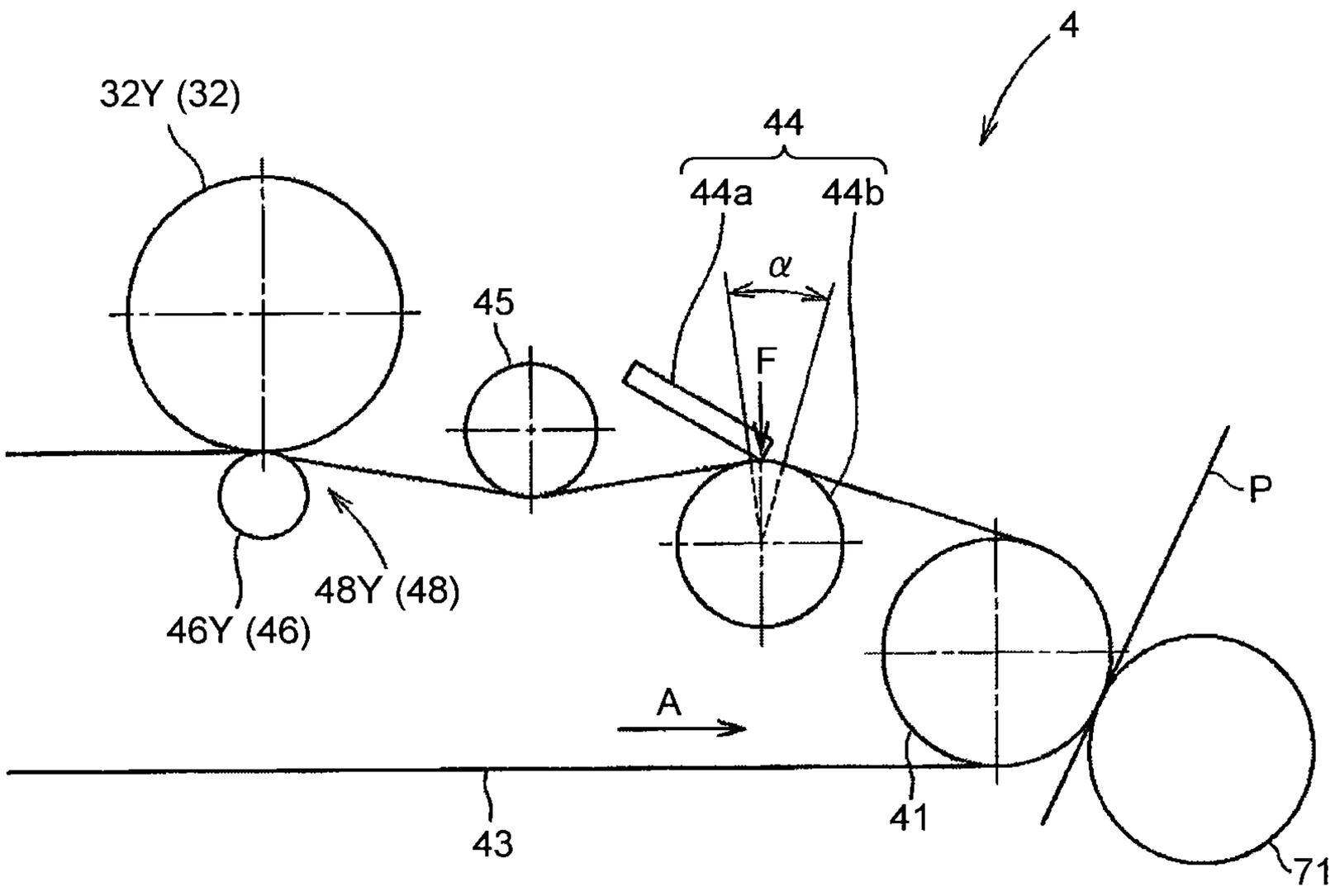


FIG.4

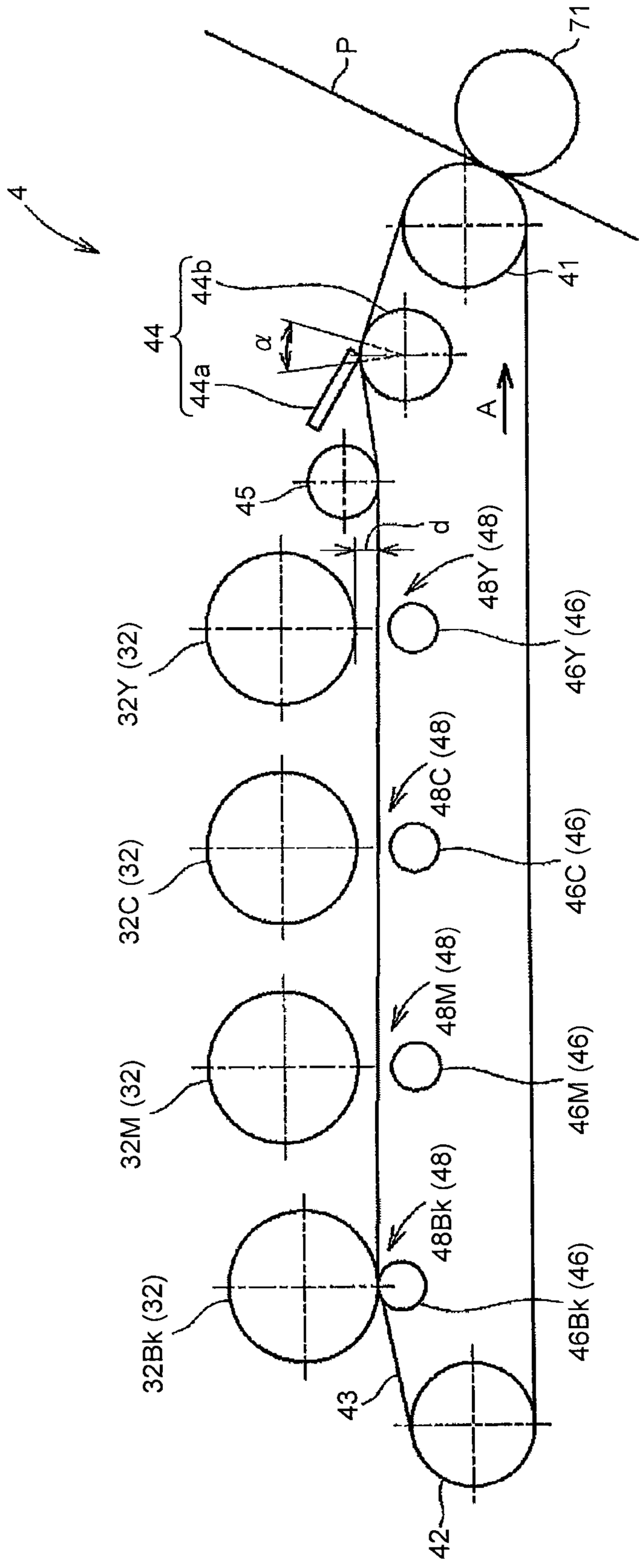

4
P
71
41
44
44b
44a
α
A
45
d
32Y (32)
48Y (48)
46Y (46)
32C (32)
48C (48)
46C (46)
32M (32)
48M (48)
46M (46)
32Bk (32)
48Bk (48)
46Bk (46)
43
42

FIG.5

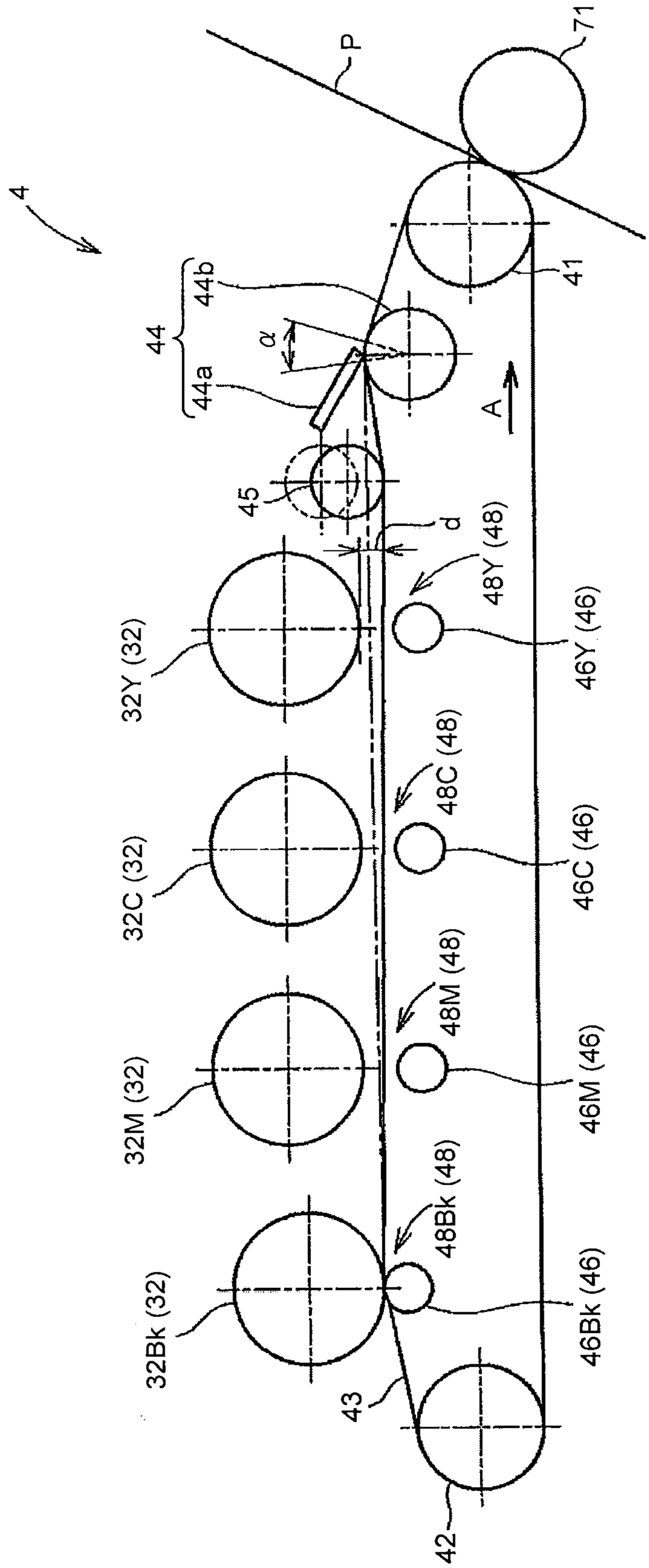

4
P
71
41
44
44b
44a
α
A
45
d
32Y (32)
48Y (48)
46Y (46)
32C (32)
48C (48)
46C (46)
32M (32)
48M (48)
46M (46)
32Bk (32)
48Bk (48)
46Bk (46)
43
42

FIG.6

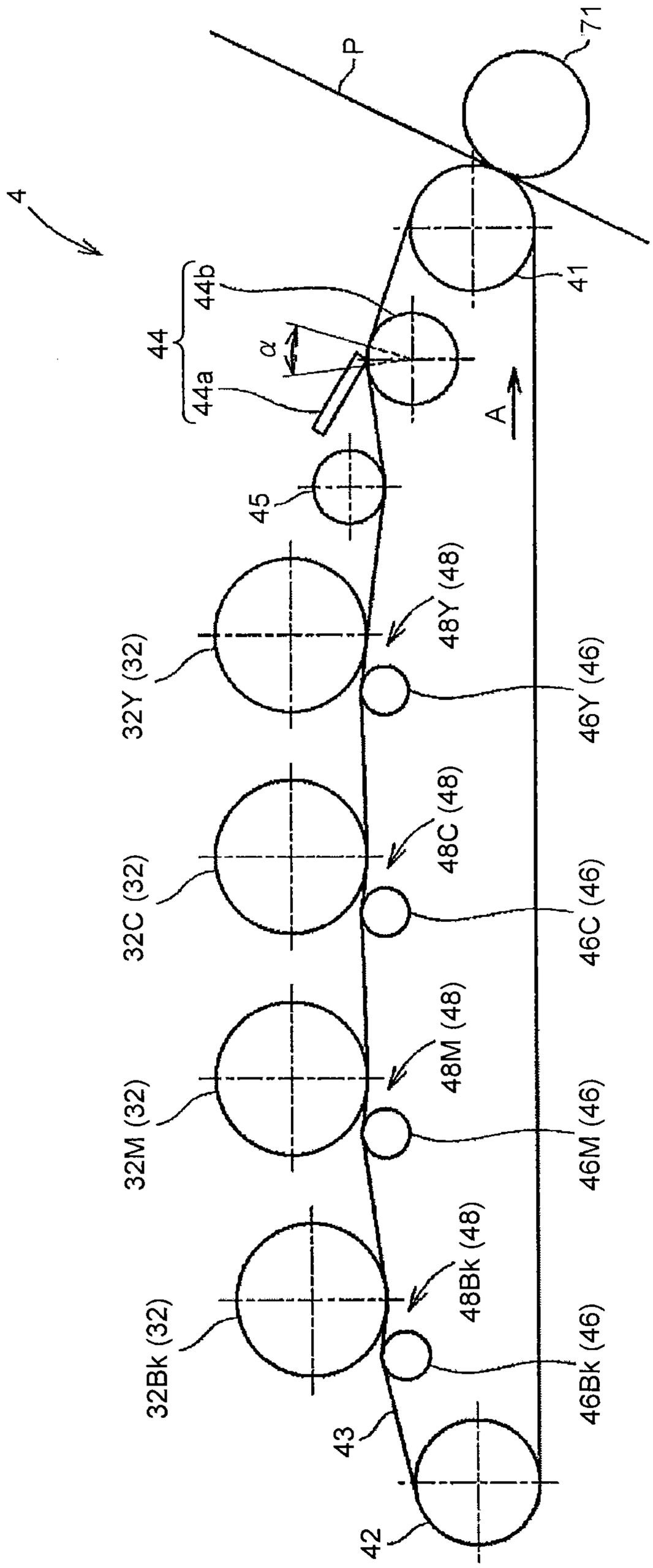
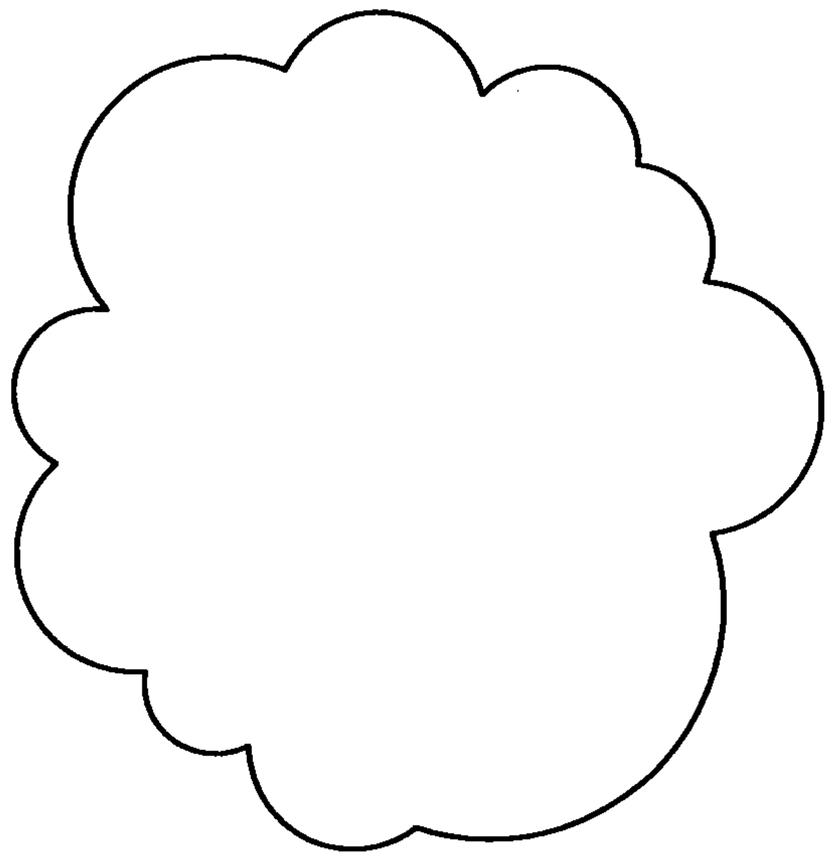
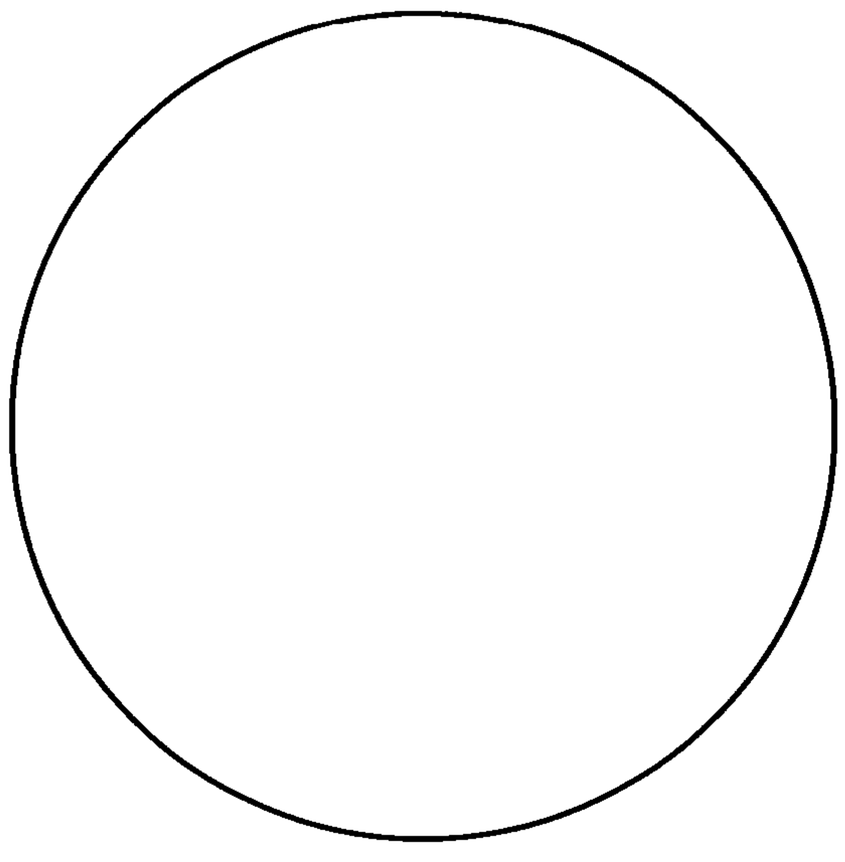

4
P
71
41
44
44b
44a
α
A
45
32Y (32)
48Y (48)
46Y (46)
32C (32)
48C (48)
46C (46)
32M (32)
48M (48)
46M (46)
32Bk (32)
48Bk (48)
46Bk (46)
43
42

FIG.7



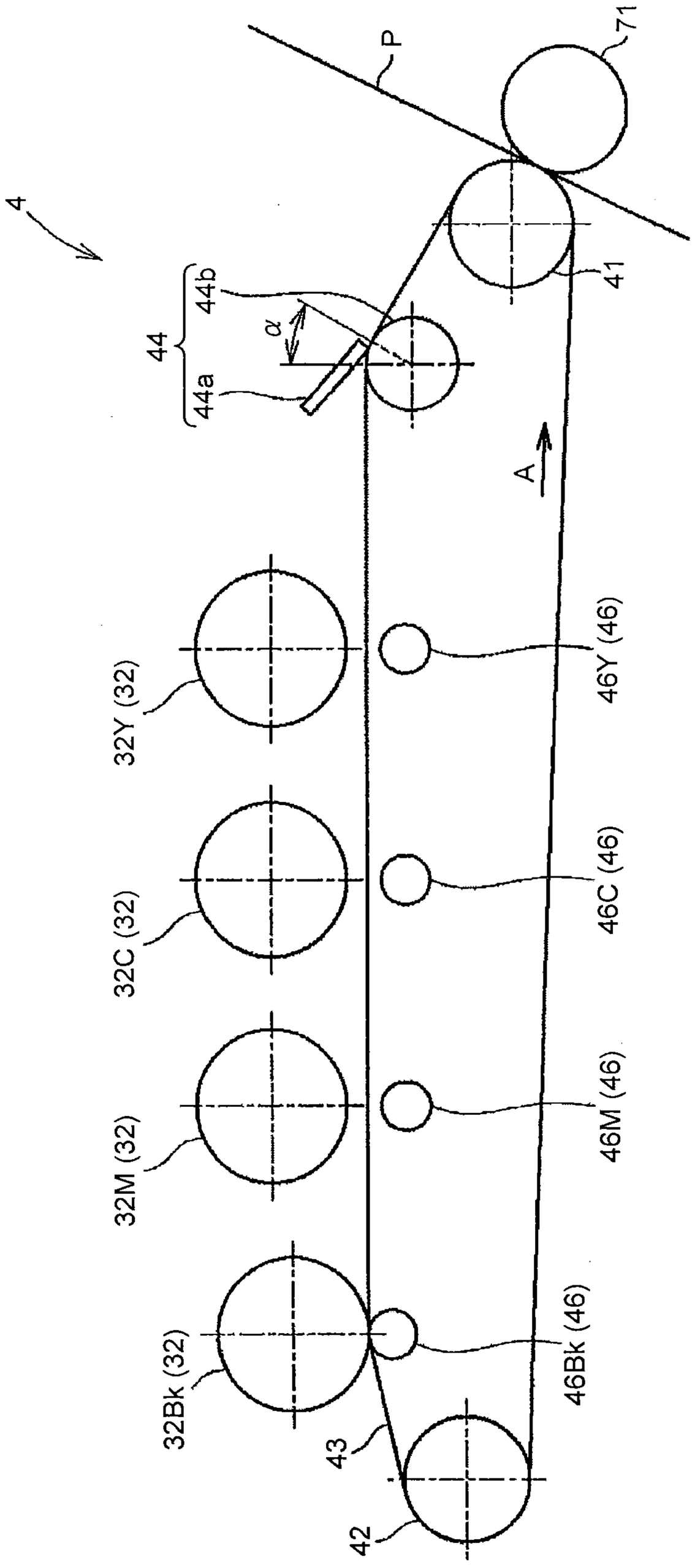
OUTER PERIMETER: Lt

FIG.8



PERFECT CIRCLE WITH AREA S
OUTER PERIMETER: Lc

FIG.9


4
P
71
41
44
44b
44a
α
A
32Y (32)
32C (32)
32M (32)
32Bk (32)
46Y (46)
46C (46)
46M (46)
46Bk (46)
43
42

BELT DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to and incorporates by reference the entire contents of Japanese Patent Application No. 2011-150913 filed in Japan on Jul. 7, 2011.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a belt device and an image forming apparatus.

2. Description of the Related Art

In an image forming apparatus of an intermediate transfer system among various image forming apparatuses, such as copiers, printers, facsimile machines, and multifunction peripherals having functions of a copier, a printer, and a facsimile machine, a toner image formed on a photosensitive drum is transferred onto a transfer belt (primary transfer) and then the toner image on the transfer belt is transferred onto a recording sheet (secondary transfer). The belt device having a transfer belt of this type includes a cleaning unit on the upstream side of the photosensitive drum in order to remove non-transferred toner attached to the transfer belt. An example of the belt device having a cleaning unit of this type is disclosed in, for example, Japanese Patent Laid-open Publication No. 2008-9011 (hereinafter, described as "Patent Document 1").

In the belt device disclosed in Patent Document 1, a photosensitive drum on the most upstream side is disposed such that the center shaft thereof is positioned closer to the transfer belt than the center shafts of other photosensitive drums so that the amount of contact between the transfer belt and a cleaning opposing roller can be increased to improve the cleaning performance of the cleaning unit (see, for example, a paragraph [0036] of Patent Document 1).

However, in the configuration disclosed in Patent Document 1, the belt is wound around the opposing roller by being stretched outward by the opposing roller. Therefore, the opposing roller needs to be disposed at an offset position outward from a belt extended line between the photosensitive drum located on the most upstream side and the driving roller. Therefore, the thickness of the belt device (the maximum size between the outer periphery on a belt forwarding side and the outer periphery on a belt returning side) increases, resulting in an increase in a space needed for the belt device in the thickness direction. In particular, when the angle of contact between the belt and the opposing roller is increased to improve the cleaning performance, the opposing roller needs to be disposed further outward, and therefore, the above-mentioned problems become more apparent.

Meanwhile, when the image forming apparatus switches from a color mode to a monochrome (single color) mode, there is a demand to stop and separate the photosensitive drums other than the photosensitive drum used in the monochrome mode from the transfer belt in order to reduce abrasion of the surfaces of the photosensitive drums or to save power consumption. Therefore, there is a need for the belt device that can meet the above demand.

Therefore, there is a need to provide a belt device and an image forming apparatus that can easily cope with image formation in the monochrome mode and that are compact in size.

SUMMARY OF THE INVENTION

It is an object of the present invention to at least partially solve the problems in the conventional technology.

According to an aspect of the present invention, there is provided a belt device including: a belt that has an endless shape and sequentially passes through a plurality of image forming units, each of the image forming units including a transfer member and an image carrier as a pair, and the transfer member being movable in a direction in which the transfer member comes into contact with the belt and in a direction in which the transfer member is separated from the belt; a cleaning unit that cleans an outer periphery of the belt after the belt passes through all the image forming units; and a pressing member that is disposed between the cleaning unit and the image forming unit located on the most upstream side and that presses the outer periphery of the belt, wherein when the transfer member of at least one of the image forming units moves in the direction in which the transfer member is separated from the belt, the transfer member of rest of the image forming units and the pressing member support the belt.

According to another aspect of the present invention, there is provided an image forming apparatus includes: a belt device including a belt that has an endless shape and sequentially passes through a plurality of image forming units, each of the image forming units including a transfer member and an image carrier as a pair, and the transfer member being movable in a direction in which the transfer member comes into contact with the belt and in a direction in which the transfer member is separated from the belt, a cleaning unit that cleans an outer periphery of the belt after the belt passes through all the image forming units, and a pressing member that is disposed between the cleaning unit and the image forming unit located on the most upstream side and that presses the outer periphery of the belt, wherein when the transfer member of at least one of the image forming units moves in the direction in which the transfer member is separated from the belt, the transfer member of rest of the image forming units and the pressing member support the belt; a secondary image-transfer unit that transfers an unfixed image formed on the belt of the belt device onto a recording medium; and a fixing unit that fixes the image on the recording medium.

The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of a color image forming apparatus according to an embodiment;

FIG. **2** is a side view illustrating a schematic configuration of a belt device according to the embodiment;

FIG. **3** is an enlarged view of the belt device illustrated in FIG. **2**;

FIG. **4** is a side view illustrating a schematic configuration of the belt device when a single-color image is formed;

FIG. **5** is a side view illustrating a schematic configuration of a belt device according to another embodiment;

FIG. **6** is a side view illustrating a schematic configuration of a belt device according to still another embodiment;

FIG. **7** is a schematic diagram for explaining an outer perimeter of a projected image of a toner;

FIG. **8** is a schematic diagram for explaining an outer perimeter of a perfect circle with the same projected area as that of the toner; and

FIG. **9** is a schematic diagram for explaining a technology related to the belt device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Exemplary embodiments of the present invention will be explained in detail below with reference to the accompanying drawings. In the drawings illustrating the embodiments, the same elements such as components or component parts having the same functions or the same shapes are denoted by the same reference numerals or symbols as long as the elements are identifiable, and therefore, the same explanation will not be repeated below.

FIG. **1** is a schematic configuration diagram of a color image forming apparatus according to an embodiment of the present invention. The color image forming apparatus illustrated in FIG. **1** includes an apparatus main body **1**, an exposing unit **2**, an image forming unit **3**, a belt device **4**, a sheet feed unit **5**, a conveying path **6**, a secondary image-transfer unit **7**, an image fixing unit **8**, a discharging unit **9**, or the like.

The exposing unit **2** is located in the upper side of the apparatus main body **1** and includes a light source that emits a laser beam or various optical systems. Specifically, the exposing unit **2** emits a laser beam for each of color-separated components of an image to be generated based on image data obtained by an image acquiring unit (not illustrated) toward a photosensitive member of the image forming unit **3** to be described **11** below, thereby exposing the surface of the photosensitive member.

The image forming unit **3** is located below the exposing unit **2** and includes a plurality of process units **31** that are detachably attachable to the apparatus main body **1**. Each of the process units **31** includes a photosensitive drum **32** that serves as an image carrier for carrying toner being a developer on the surface of the photosensitive drum **32**, a charging roller **33** that uniformly charges the surface of the photosensitive drum **32**, a developing device **34** that supplies toner to the surface of the photosensitive drum **32**, a cleaning unit **35** that cleans the surface of the photosensitive drum **32**, or the like. As the process units **31**, four process units **31** (**31**Y, **31**C, **31**M, and **31**Bk) are provided for respective colors of yellow, cyan, magenta, and black that are the color-separated components of a color image. The process units **31** have the same configurations except for colors of toner stored therein.

The belt device **4** is located just below the image forming unit **3**. The belt device **4** includes an intermediate transfer belt **43** that is an endless belt wound around a driving roller **41** and a driven roller **42**, which serve as supporting members, in a rotationally movable manner, a cleaning unit **44** that cleans the surface of the intermediate transfer belt **43**, a pressing roller **45** that serves as a pressing member for pressing the outer periphery of the intermediate transfer belt **43** inward, primary transfer rollers **46** that serve as a transfer member and are located opposite the photosensitive drums **32** across the intermediate transfer belt **43**, or the like. A waste toner container **47** for housing waste toner collected by the cleaning unit **44** through cleaning is disposed below the intermediate transfer belt **43** via a waste toner transfer hose (not illustrated).

The cleaning unit **44** includes a cleaning blade **44***a* that slides on the outer periphery of the intermediate transfer belt **43** to clean up toner from the outer periphery of the intermediate transfer belt **43**, and a cleaning opposing roller **44***b* that is in contact with the inner periphery of the intermediate transfer belt **43** at the position opposite the cleaning blade **44***a*.

The photosensitive drums **32** of the process units **31** and the primary transfer rollers **46** of the belt device **4** form image forming units **48**, respectively.

As the primary transfer rollers **46**, four primary transfer rollers **46** (**46**Y, **46**C, **46**M, and **46**Bk) are disposed opposite the four photosensitive drums **32** (**32**Y, **32**C, **32**M, and **32**Bk) for the respective colors of yellow, cyan, magenta, and black as the color-separated components of a color image. Therefore, the four image forming units **48** (**48**Y, **48**C, **48**M, and **48**Bk), each of which is formed of a corresponding pair of the photosensitive drum **32** and the primary transfer roller **46**, are formed at four positions on the intermediate transfer belt **43** in a moving direction of the intermediate transfer belt **43**. The cleaning unit **44** is located upstream of the image forming unit **48**Y on the most upstream side and is disposed linearly along the four image forming units **48**. The cleaning opposing roller **44***b* of the cleaning unit **44** and the primary transfer rollers **46** (**46**Y, **46**C, **46**M, and **46**Bk) are disposed such that the intermediate transfer belt **43** wound around the driving roller **41** and the driven roller **42** is stretched outward. The primary transfer rollers **46** press the inner periphery of the intermediate transfer belt **43** at the respective positions, so that primary transfer nips are formed between the primary transfer rollers **46** and the photosensitive drums **32**, respectively.

To cope with a monochrome mode to be described later, of all the primary transfer rollers **46**, the primary transfer rollers **46**Y, **46**C, and **46**M except for the primary transfer roller **46**Bk of the image forming unit **48**Bk for black are movable by a driving mechanism (not illustrated) in directions in which the primary transfer rollers **46**Y, **46**C, and **46**M come into contact with and away from the intermediate transfer belt **43**.

The sheet feed unit **5** is located in the lower side of the apparatus main body **1** and includes a sheet feed tray **51** for housing a recording sheet P as a recording medium, a sheet feed roller **52** for taking out the recording sheet P from the sheet feed tray **51**, or the like.

The conveying path **6** is a conveying pathway for conveying the recording sheet P taken out from the sheet feed unit **5**. Conveying roller pairs (not illustrated) including a registration roller pair **61** are appropriately disposed on the conveying path **6** toward the discharging unit **9** to be described later.

The secondary image-transfer unit **7** is located in the middle of the conveying path **6** and includes the driving roller **41** of the intermediate transfer belt **43**, and a secondary transfer roller **71** disposed opposite the driving roller **41** across the intermediate transfer belt **43**. The secondary transfer roller **71** presses the outer periphery of the intermediate transfer belt **43**, so that a secondary transfer nip is formed between the secondary transfer roller **71** and the driving roller **41**.

The image fixing unit **8** is located downstream of the secondary image-transfer unit **7** on the conveying pathway and includes a fixing roller **81** heated by a heat source (not illustrated), a pressurizing roller **82** that applies pressure to the fixing roller **81**, or the like.

The discharging unit **9** is located on the most downstream side of the conveying path in the apparatus main body **1** and includes a sheet discharge roller pair **91** for discharging the recording sheet P to the outside and a sheet discharge tray **92** for stacking a discharged recording medium.

A basic operation of the color image forming apparatus described above will be explained below with reference to FIG. **1**.

In the image forming apparatus, when an image formation in a color mode is started, the photosensitive drums **32** of the process units **31**Y, **31**C, **31**M, and **31**Bk are rotated clockwise in FIG. **1** by a driving device (not illustrated), and the charging rollers **33** uniformly charge the surfaces of the photosensitive drums **32** with a predetermined polarity. The exposing unit **2** applies laser beams for respective color components of an image to be formed to the charged surfaces of the photosensitive drums **32**, so that electrostatic latent images are formed on the surfaces of the photosensitive drums **32**. At this time, image information exposed on each of the photosensitive drums **32** is information on a single-color image that is obtained by separating a desired full-color image into pieces of color information on yellow, cyan, magenta, and black. The developing devices **34** supply toner as a developer onto the electrostatic latent images formed on the photosensitive drums **32**, so that the electrostatic latent images are visualized as toner images (developed images) that are visible images. As the developer, one-component developer formed of only toner or two-component developer formed of toner and carrier may be used.

Subsequently, the driving roller **41** of the belt device **4** is rotated counterclockwise in FIG. **1**, so that the intermediate transfer belt **43** moves in an arrow A direction in FIG. **1**. A constant voltage with a polarity opposite the polarity of charged toner or a voltage subjected to constant current control is applied to the primary transfer rollers **46**. Therefore, transfer electric fields are formed at the respective primary transfer nips between the primary transfer rollers **46** and the photosensitive drums **32**. Subsequently, the toner images for the respective colors formed on the photosensitive drums **32** of the process units **31**Y, **31**C, **31**M, and **31**Bk are transferred onto the intermediate transfer belt **43** in a superimposed manner by the transfer electric fields formed at the primary transfer nips. As a result, a full-color toner image (an unfixed image), in which the images formed by the image forming units **48** are superimposed on one another, is formed on the surface of the intermediate transfer belt **43** after the intermediate transfer belt **43** passes through the image forming units **48** (**48**Y, **48**C, **48**M, and **48**Bk). The transfer member is not limited to the primary transfer rollers **46**. A conductive member, such as a brush, may be used as the transfer member.

Subsequently, the cleaning unit **35** removes non-transferred toner attached to the surfaces of the photosensitive drums **32** and a neutralizing device (not illustrated) neutralizes the surfaces of the photosensitive drums **32**, so that the surface potential is initialized in preparation for next image formation. It is possible not to provide the cleaning unit **35** but to cause the developing devices **34** to collect the non-transferred toner attached to the surfaces of the photosensitive drums **32**. Alternatively, it is possible to employ various known cleaning means. The intermediate transfer belt **43** further moves along with the rotation of the driving roller **41**, so that the toner images formed on the surface of the intermediate transfer belt **43** are conveyed toward the secondary image-transfer unit **7**.

Meanwhile, in the lower side of the apparatus main body **1**, a recording sheet P housed in the sheet feed tray **51** is fed toward the conveying path **6** along with rotation of the sheet feed roller **52** of the sheet feed unit **5**. The recording sheet P fed to the conveying path **6** is conveyed to the secondary transfer nip between the secondary transfer roller **71** of the secondary image-transfer unit **7** and the driving roller **41** opposite the secondary transfer roller **71** at a certain timing adjusted by the registration roller pair **61**. At the secondary transfer nip, the full-color toner image formed on the surface of the intermediate transfer belt **43** is transferred onto the recording sheet P. At this time, a transfer voltage with a polarity opposite the polarity of charged toner attached to the toner image on the intermediate transfer belt **43** is applied to the secondary transfer roller **71**, so that a transfer electric field is formed at the secondary transfer nip. The toner images formed on the intermediate transfer belt **43** are collectively transferred (transfer by attractive force) onto the recording sheet P due to the transfer electric field formed at the secondary transfer nip.

It may be possible to apply a transfer voltage with the same polarity as the polarity of charged toner to the driving roller **41** in the secondary image-transfer unit **7** so that the toner images can be transferred onto the recording sheet P by repulsive force against the driving roller **41** (transfer by repulsive force).

Thereafter, non-transferred toner attached to the intermediate transfer belt **43** is removed by the cleaning blade **44***a* of the cleaning unit **44**. The removed toner is conveyed and collected into the waste toner container **47** by a screw (not illustrated), a toner transfer hose (not illustrated), or the like.

Subsequently, the recording sheet P on which the toner image is transferred is conveyed to the image fixing unit **8**, where the heated fixing roller **81** and the pressurizing roller **82** apply heat and pressure to the recording sheet P to fix the toner image on the recording sheet P. The recording sheet P on which the toner image is fixed is conveyed by the conveying roller pairs (not illustrated) and discharged to the sheet discharge tray **92** by the sheet discharge roller pair **91** of the discharging unit **9**. The fixation operation may be performed by the secondary image-transfer unit **7**.

The belt device **4** of the image forming apparatus according to the embodiment will be explained in detail below with reference to FIGS. **2** and **3**.

As illustrated in FIG. **2**, in the belt device **4**, the pressing roller **45** is disposed at a fixed position between the image forming unit **48**Y located on the most upstream side in the moving direction of the intermediate transfer belt **43** and the cleaning unit **44** (specifically, between the primary transfer nip located on the most upstream side and a contact portion of the cleaning blade **44***a* and the cleaning opposing roller **44***b*). The pressing roller **45** presses the intermediate transfer belt **43** so that the intermediate transfer belt **43** is in a reversely-bent state, in which the intermediate transfer belt **43** is bent inward from a belt extended line between the photosensitive drum **32**Y and the cleaning opposing roller **44***b*.

In this way, by disposing the pressing roller **45** between the image forming unit **48**Y and the cleaning unit **44**, it is possible to press the pressing roller **45** against the surface of the intermediate transfer belt **43** that has been cleaned. Therefore, it is possible to prevent non-transferred toner remaining on the intermediate transfer belt **43** from being attached to the surface of the pressing roller **45**. Furthermore, it is possible to prevent non-transferred toner attached to the pressing roller **45** from being attached to the intermediate transfer belt **43** again. Therefore, it is possible to prevent the intermediate transfer belt **43** from getting dirty, enabling to prevent adverse effects on image quality. As a result, it is possible to lengthen the lifetime of the intermediate transfer belt **43**, enabling to provide the color image forming apparatus that can form an image of stable quality.

In contrast with the present embodiment, when the pressing roller **45** is disposed upstream of the cleaning unit **44** and it is desired to prevent the above disadvantage, for example, it is necessary to apply a bias with the same polarity as the polarity of the toner to the pressing roller **45** or to coat the surface of the pressing roller **45** with a low friction material, such as fluorine resin, in order to prevent non-transferred

toner from being attached to the pressing roller **45**. However, this may increase costs. By contrast, by disposing the pressing roller **45** between the image forming unit **48**Y located on the most upstream side and the cleaning unit **44** as described above, it is possible to obtain a high-quality image at low costs.

FIG. **3** is an enlarged view of the belt device **4**. As illustrated in FIG. **3**, the intermediate transfer belt **43** is reversely bent by the pressing roller **45**, so that an angle of contact α between the intermediate transfer belt **43** and the outer periphery of the cleaning opposing roller **44***b* increases. The cleaning blade **44***a* slides on the intermediate transfer belt **43** at a linear pressure F to be described later within the range of the angle of contact α. In this way, by securing the adequate angle of contact α, it is possible to stably move the intermediate transfer belt **43** and cause the cleaning blade **44***a* to stably perform cleaning.

When the pressing roller **45** is not used, as illustrated in FIG. **9** for example, the angle of contact α may be increased by increasing the amount of offset of the cleaning opposing roller **44***b* toward the outside (the amount of offset in a direction away from a line connecting the center of the driving roller **41** and the center of the driven roller **42**). However, in this case, the size of the belt device **4** in the thickness direction increases and the flexibility in arrangement of the cleaning opposing roller **44***b* and the driving roller **41** in the vertical direction is limited, resulting in reduced flexibility in design or increased size of the image forming apparatus. By contrast, by reversely bending the intermediate transfer belt **43** by using the pressing roller **45** as described above, it is possible to increase the amount of pressing the pressing roller **45** inward, enabling to increase the angle of contact α. Therefore, it is not necessary to increase the amount of offset of the cleaning opposing roller **44***b* toward the outside, enabling to prevent an increase in the size of the belt device **4** in the thickness direction and reduce the entire size of the belt device.

When the image forming apparatus described above switches from the color mode to the monochrome mode, as illustrated in FIG. **4**, some of the image forming units, that is, the image forming units for colors other than a color used in the monochrome mode (for example, the image forming units **48**Y, **48**C, and **48**M for colors), activate the driving mechanisms of the primary transfer rollers **46**Y, **46**C, and **46**M in order to move the primary transfer rollers **46**Y, **46**C, and **46**M in a direction in which the primary transfer rollers **46**Y, **46**C, and **46**M are separated from the intermediate transfer belt **43**. On the other hand, other image forming unit, that is, the image forming unit corresponding to the color to be used (for example, the image forming unit **48**Bk for black) does not move the primary transfer roller **46**Bk, so that the primary transfer nip is maintained.

In the present embodiment, the pressing roller **45** presses the intermediate transfer belt **43** from the outside to the inside to reversely bend the intermediate transfer belt **43**. Therefore, when the primary transfer rollers **46**Y, **46**C, and **46**M move, the intermediate transfer belt **43** is changed to a non-contact state, in which the intermediate transfer belt **43** is separated from the photosensitive drums **32**Y, **32**C, and **32**M of the image forming units **48**Y, **48**C, and **48**M for colors. Accordingly, the intermediate transfer belt **43** is supported by the primary transfer roller **46**Bk of the image forming unit **48**Bk for black located on the most downstream side and the pressing roller **45**. Therefore, it is possible to stop the photosensitive drums **32**Y, **32**C, and **32**M for colors during printing, enabling to reduce abrasion of the surfaces of the photosensitive drums or save power consumption. At this time, it is desirable to move the primary transfer rollers **46**Y, **46**C, and **46**M for colors to positions where the primary transfer rollers **46**Y, **46**C, and **46**M are not in contact with the intermediate transfer belt **43**.

To cope with the monochrome mode, as illustrated in FIGS. **2** and **4**, it is desirable to align the rotation centers of the photosensitive drums **32**Y, **32**C, and **32**M for colors on a line and set the line to be parallel to a belt extended line between the pressing roller **45** and the image forming unit **48**Bk for black. With this configuration, a gap d between each of the photosensitive drums **32**Y, **32**C, and **32**M of the image forming units **48** for colors and the intermediate transfer belt **43** can be uniform, so that it is possible to assuredly prevent each of the photosensitive drums **32**Y, **32**C, and **32**M for colors from coming into contact with the intermediate transfer belt **43**. In this case, it is desirable to arrange the rotation center of the photosensitive drum **32**Bk for black at a position closer to the intermediate transfer belt **43** than the rotation centers of the photosensitive drums **32**Y, **32**C, and **32**M for colors.

As described in the present embodiment, when the pressing roller **45** is disposed between the image forming unit **48**Y located on the most upstream side and the cleaning unit **44**, the angle of contact α of the cleaning opposing roller **44***b* does not change before and after the primary transfer rollers **46**Y, **46**C, and **46**M move in the direction in which the primary transfer rollers **46**Y, **46**C, and **46**M are separated from the intermediate transfer belt **43** or in the direction in which the primary transfer rollers **46**Y, **46**C, and **46**M come into contact with the intermediate transfer belt **43**. Therefore, the cleaning unit **44** can achieve the same cleaning performance both in the color mode and in the monochrome mode.

In the above example, it is explained that the image forming units **48** for respective colors are arranged in the order of the image forming units **48** for yellow, cyan, magenta, and black toward the downstream side in the conveying direction of the intermediate transfer belt **43**; however, the order of arranging the image forming units **48** is not limited to this example. Even when a single or a plurality of the image forming units **48** are used for image formation without using the rest of the image forming units **48**, similarly to the above, it is possible to move the unused image forming units **48** to the positions at which the primary transfer rollers **46** do not come into contact with the intermediate transfer belt **43**, support the intermediate transfer belt **43** by the primary transfer rollers **46** of the image forming units **48** corresponding to colors to be used and the pressing roller **45**, and separate the photosensitive drums **32** of the unused image forming units **48** from the intermediate transfer belt **43**. Furthermore, while it is explained that a part of the primary transfer rollers (the primary transfer roller **46**Bk for black) is disposed at the fixed position, it is possible to configure the image forming unit **48**Bk so that the image forming unit **48**Bk can move in directions in which the image forming unit **48**Bk comes in contact with and away from the intermediate transfer belt **43**, similarly to the primary transfer rollers **46**Y, **46**C, and **46**M. Namely, it is possible to configure all the primary transfer rollers **46**Y, **46**C, **46**M, and **46**Bk such that the primary transfer rollers **46**Y, **46**C, **46**M, and **46**Bk can move in directions approaching and away from the intermediate transfer belt **43**.

In the color image forming apparatus of the present embodiment, when, for example, spherical toner with average circularity of 0.98 or greater is used, the liner pressure F of the cleaning blade **44***a* against the intermediate transfer belt **43** needs to be set to at least 40 N/m or greater in order to secure adequate cleaning performance of the cleaning blade **44***a*. The linear pressure F of the cleaning blade **44***a* against the intermediate transfer belt **43** is a value obtained by divid-

ing the total weight applied to the cleaning blade **44***a* by a length of an edge line of a tip portion of the cleaning blade **44***a* pressed against the intermediate transfer belt **43**.

The average circularity of toner can be measured by using flow particle image analyzer FPIA-2000 (which is the name of a product manufactured by Sysmex Corporation). Specifically, a surfactant, or more preferably, alkylbenzene sulfonate of 0.1 milliliter to 0.5 milliliter is added as a dispersant to water of 100 milliliters to 150 milliliters in a container from which impure solids are removed in advance, and a measurement sample (toner) of approximately 0.1 gram to 0.5 gram is further added to the water. Thereafter, the suspended solution, in which the toner is dispersed, is subjected to dispersion treatment by an ultrasonic disperser for about 1 minute to 3 minutes to obtain the dispersion liquid at the concentration of 30 millions per microliter to 10 thousands per microliter, and the dispersion liquid is set in the analyzer to measure the size and the distribution of the toner. By using the measurement result, Lc/Lt is obtained, where Lc is the outer perimeter of the projected shape of the toner (FIG. **7**) and Lt is the outer perimeter Lc of a perfect circle having the same area as a projected area S of the toner (FIG. **8**), and thereafter, an average of obtained values Lc/Lt is obtained as the circularity.

In the present embodiment, when spherical toner with the average circularity of 0.98 or greater is used, linear pressure F**1** of the cleaning blade **44***a* is set to 45 N/m. In this way, when the linear pressure F**1** of the cleaning blade **44***a* is set to 40 N/m or greater to secure adequate cleaning performance, resistance of the cleaning blade **44***a* due to the movement of the intermediate transfer belt **43** in the moving direction increases. Therefore, the intermediate transfer belt **43** is deflected at a position upstream of the contact position of the cleaning blade **44***a* and the intermediate transfer belt **43** in the moving direction of the intermediate transfer belt **43**, so that the oscillation (behavior) of the intermediate transfer belt **43** easily becomes unstable. By contrast, in the present embodiment, because the pressing roller **45** presses the intermediate transfer belt **43**, a tensile force is applied to the intermediate transfer belt **43**. Therefore, it is possible to prevent deflection of the intermediate transfer belt **43**.

In the above example, it is explained that the pressing roller **45** is disposed at the fixed position. However, the pressing roller **45** may be configured such that the pressing roller **45** is movable in directions in which the pressing roller **45** comes in contact with and away from the intermediate transfer belt **43** as illustrated in FIG. **5**. With this configuration, for example, the pressing roller **45** can be moved to and maintained at the position separated from the intermediate transfer belt **43** while the belt device **4** is deactivated or not in use. Therefore, it is possible to prevent the intermediate transfer belt **43** from being permanently deformed or being permanently curled due to the press against the pressing roller **45** for a long time.

Even when the pressing roller **45** is separated from the intermediate transfer belt **43** as described above, as indicated by a chain double-dashed line in FIG. **5**, it is desirable to set the position of the cleaning opposing roller **44***b* such that the intermediate transfer belt **43** does not come into contact with the photosensitive drums **32** (in particular, the intermediate transfer belt **43** does not come into contact with the photosensitive drums **32**Y, **32**C, and **32**M during printing in the monochrome mode). When both of the photosensitive drums **32** and the intermediate transfer belt **43** are stopped, it is allowable that the photosensitive drums **32** and the intermediate transfer belt **43** come into contact with each other.

The secondary transfer roller **71** of the secondary image-transfer unit **7** may be configured such that the secondary transfer roller **71** comes into contact with or comes away from the intermediate transfer belt **43** by a contact-separate mechanism (not illustrated). Therefore, by separating the secondary transfer roller **71** from the intermediate transfer belt **43** when an image forming operation is not performed, it is possible to prevent plastic deformation (creep) that occurs on the secondary transfer roller **71** or the surface of the intermediate transfer belt **43** when the secondary transfer roller **71** and the intermediate transfer belt **43** are in contact with each other while being stopped for a long time.

Meanwhile, when the image forming unit **48** (**48**Y, **48**C, **48**M, or **48**Bk) primary transfers a toner image onto the intermediate transfer belt **43** and when the secondary image-transfer unit **7** transfers the toner image onto the recording sheet P, the primary transfer roller **46** or the secondary transfer roller **71** apply a transfer bias to the intermediate transfer belt **43**. Therefore, in some cases, residual potential remains on the surface of the intermediate transfer belt **43** after the intermediate transfer belt **43** has passed through the secondary image-transfer unit **7**. In this case, to prevent charge up due to the residual potential on the surface of the intermediate transfer belt **43**, it is desirable to apply conductivity to the pressing roller **45** and to ground (earth) the pressing roller **45**. For example, if the roller is made with metal (conductive metal), a conductive roller as described above can be obtained at low costs.

Furthermore, if the surface of the pressing roller **45** is made with an elastic material, such as rubber or sponge, the degree of attack to the surface of the intermediate transfer belt **43** is weakened. Therefore, it is possible to lengthen the lifetime of the intermediate transfer belt **43**. At this time, if a conductive material is used as the elastic material of the surface of the pressing roller **45**, it is also possible to prevent charge up due to the residual potential.

Furthermore, in the present embodiment, the example is explained in which the rotatable pressing roller **45** is used as the pressing member; however, it is not limited thereto. For example, a non-rotatable member, such as a pad or a pressing bar, may be used as the pressing member. When such a non-rotatable member is used, it is desirable to form a low friction film made with fluorine resin or the like on the sliding portion of the belt.

The number of the photosensitive drums **32** or the primary transfer rollers **46** to be arranged is not limited to four but may be three or smaller or five or greater.

Furthermore, in the belt device **4** of the present embodiment, the primary transfer rollers **46** are disposed just below the photosensitive drums **32** across the intermediate transfer belt **43**; however, it is not limited thereto. For example, as illustrated in FIG. **6**, the primary transfer rollers **46** may be disposed at a position (an offset position) deviated from the perpendicular line extending from the respective centers of the photosensitive drums **32** toward the intermediate transfer belt **43**. Even in this case, the angle of contact α between the intermediate transfer belt **43** and the cleaning opposing roller **44***b* can be adequately secured, so that it is possible to stably move the cleaning opposing roller **44***b* and cause the cleaning blade **44***a* to stably perform cleaning.

While the embodiments of the present invention are described above, the present invention is not limited to the above embodiments. The present invention can be modified in various forms within the scope of the technical idea of the present invention. In the embodiments described above, the configuration of the present invention is applied to the belt device. However, the configuration of the present invention may be applied to a belt device that drives a photoreceptor belt, which is an electrostatic latent image carrier for carrying an electrostatic latent image on the surface thereof. Further-

more, the image forming apparatus according to the present invention is not limited to the color image forming apparatus illustrated in FIG. **1** but may be applied to a monochrome image forming apparatus, a copier, a printer, a facsimile machine, or a multifunction peripheral having functions of a copier, printer, and a facsimile machine.

According to one embodiment of the present invention, it is possible to provide a belt device that is compact in size and can easily cope with image formation in the monochrome mode.

With this configuration, the belt is pressed inward by the pressing member, so that the belt is reversely bent near the cleaning unit. With the reversely-bent state of the belt, the belt can be wound around the cleaning unit. Because the belt is wound by using the inward pressing force, it is possible to reduce an increase in size of the belt device in the thickness direction and reduce the entire size of the belt device.

Furthermore, when some of the transfer members of the image forming units are moved in a direction away from the belt, the belt is supported by the transfer member of other image forming unit and the pressing member and the transfer nips formed between the transfer members of the other image forming units and the photosensitive drums are maintained. Therefore, it is possible to transfer images onto the belt by the other image forming units in the monochrome mode. At the same time, the transfer members of the some of the image forming units are moved in a direction away from the belt such that the photosensitive drums of the some of the image forming units are separated from the belt. Therefore, rotation of the photosensitive drums of the image forming units that are not used in the monochrome mode can be stopped. As a result, it is possible to prevent abrasion of the photosensitive drums or save power consumption.

Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

What is claimed is:

1. A belt device comprising:

a belt that has an endless shape and sequentially passes through a plurality of image forming units, each of the image forming units including a transfer member and an image carrier as a pair, and the transfer member being movable in a direction in which the transfer member comes into contact with the belt and in a direction in which the transfer member is separated from the belt;

a cleaning unit that cleans an outer periphery of the belt after the belt passes through all the image forming units; and

a pressing member that is disposed between the cleaning unit and the image forming unit located on the most upstream side of the plurality of image forming units in a direction of rotation of the belt and that presses the outer periphery of the belt, wherein

when the transfer member of at least one of the image forming units moves in the direction in which the transfer member is separated from the belt, the transfer member of a rest of the image forming units and the pressing member support the belt,

wherein the at least one of the image forming units are the image forming units other than the image forming unit located on the most downstream side of the plurality of image forming units in a direction of rotation of the belt,

wherein the rest of the image forming units is the image forming unit located on the most downstream side of the plurality of image forming units in a direction of rotation of the belt, and

wherein, when the transfer member of the at least one of the image forming units is separated from the belt, a line extending through a rotation center of the image carriers of the image forming units other than the image forming unit located on the most downstream side is parallel to a portion of the belt that extends between the pressing member and the image forming unit located on the most downstream side.

2. The belt device according to claim **1**, wherein

the cleaning unit includes:

a cleaning blade that slides on the outer periphery of the belt; and

a cleaning opposing roller that comes into contact with an inner periphery of the belt at a position opposite the cleaning blade, wherein

the belt is wound around the cleaning opposing roller by being pressed by the pressing roller.

3. The belt device according to claim **2**, wherein

an angle of contact between the belt and the cleaning opposing roller is constant before and after the transfer member of the at least one of the image forming units moves in the direction in which the transfer members come into contact with the belt or in the direction in which the transfer members are separated from the belt.

4. The belt device according to claim **1**, wherein the position of the pressing member is fixed.

5. The belt device according to claim **1**, wherein the position of the pressing member is movable in a direction in which the pressing member comes into contact with the belt and in a direction in which the pressing member is separated from the belt.

6. The belt device according to claim **1**, wherein the pressing member is a conductive roller and is grounded.

7. The belt device according to claim **1**, wherein the pressing member is a roller having a surface made with an elastic material.

8. An image forming apparatus comprising:

a belt device including:

a belt that has an endless shape and sequentially passes through a plurality of image forming units, each of the image forming units including a transfer member and an image carrier as a pair, and the transfer member being movable in a direction in which the transfer member comes into contact with the belt and in a direction in which the transfer member is separated from the belt,

a cleaning unit that cleans an outer periphery of the belt after the belt passes through all the image forming units, and

a pressing member that is disposed between the cleaning unit and the image forming unit located on the most upstream side of the plurality of image forming units in a direction of rotation of the belt and that presses the outer periphery of the belt, wherein when the transfer member of at least one of the image forming units moves in the direction in which the transfer member is separated from the belt, the transfer member of a rest of the image forming units and the pressing member support the belt;

a secondary image-transfer unit that transfers an unfixed image formed on the belt of the belt device onto a recording medium; and

a fixing unit that fixes the image on the recording medium,

wherein the at least one of the image forming units are the image forming units other than the image forming unit located on the most downstream side of the plurality of image forming units in a direction of rotation of the belt,

wherein the rest of the image forming units is the image forming unit located on the most downstream side of the plurality of image forming units in a direction of rotation of the belt, and

wherein, when the transfer member of the at least one of the image forming units is separated from the belt, a line extending through a rotation center of the image carriers of the image forming units other than the image forming unit located on the most downstream side is parallel to a portion of the belt that extends between the pressing member and the image forming unit located on the most downstream side.

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